WHAT IS CLAIMED IS:

1. A semiconductor device comprising:

a semiconductor substrate having a first conductivity type and including an side wall and a bottom face enclosed by the side wall;

a plate electrode having a second conductivity type different from the first conductivity type, wherein the plate electrode is provided from the bottom face to the side wall in the semiconductor substrate;

a capacitor insulating film provided on the bottom face and the side wall;

a collar oxide film provided on the side wall, a ring-shaped lower end of the collar oxide film being in contact with the capacitor insulating film and the collar oxide film is in contact with the plate electrode;

a storage electrode provided on the plate electrode and the capacitor insulating film, a height of an upper surface of the storage electrode is higher than a height of an upper end of the collar oxide film;

a capacitor extraction electrode provided on the upper end of the collar oxide film and on the upper surface of the storage electrode, the capacitor extraction electrode being electrically connected to the storage electrode and in contact with an upper part of the side wall; and

a buried strap region provided within the semiconductor substrate including the upper part of the side wall, the buried strap region being in contact with the collar oxide film and electrically connected to the capacitor extraction electrode, the buried strap region having the second conductivity type.

2. The semiconductor device as claimed in claim 1, wherein a normal

stress on the collar oxide film with respect to the side wall is a tensile stress.

3. The semiconductor device as claimed in claim 1, wherein the collar oxide film is provided on the side wall by deposition.

4. The semiconductor device as claimed in claim 1, wherein the collar oxide film is provided on the side wall by a chemical vapor deposition (CVD) method.

5. The semiconductor device as claimed in claim 1, wherein a height of an interface between the storage electrode and the capacitor extraction electrode is higher than that of a plane on which a lower end of the collar oxide film is an outer edge.

6. The semiconductor device as claimed in claim 1, further comprising:

an isolation region provided on the capacitor extraction electrode;

a drain region provided within the semiconductor substrate including an upper surface of the semiconductor substrate, wherein the drain region is electrically connected to the buried strap region and having the second conductivity type;

a gate insulating film provided on the upper surface of the semiconductor substrate;

a gate electrode provided on the gate insulating film and above the drain region;

a source region provided under the gate insulating film, below the gate electrode, and separate from the drain region within the semiconductor substrate including the upper surface of the semiconductor substrate, wherein the source region having the second conductivity type; and

a bit line electrically connected to the source region.

7. The semiconductor device as claimed in claim 1, wherein in the

storage electrode, a width at a side wall in contact with the capacitor insulating film is larger than that at a side wall in contact with the collar oxide film.

8. The semiconductor device as claimed in claim 1, further comprising:

irregularities provided on the bottom face and on the side wall of the semiconductor substrate.

9. A method of making of a trench capacitor comprising:

forming a trench on a surface of a semiconductor substrate having a first conductivity type;

forming a first insulating film on an side wall of the trench;

burying a semiconductor film in the trench on the first insulating film;

etching the first insulating film and the semiconductor film located in an upper part of the trench;

depositing a second insulating film on an exposed side wall of the trench;

etching the semiconductor film;

etching the first insulating film;

forming a plate electrode of a second conductivity type different from the first conductivity type on the exposed side wall of the trench by a vapor-phase diffusion method;

forming a capacitor insulating film on the plate electrode; and

burying a storage electrode in the capacitor insulating film and in the second insulating film within the trench.

10. The method as claimed in claim 9, further comprising:

etching an upper part of the storage electrode and an upper part of

the second insulating film;

forming a buried strap region having the second conductivity type in the exposed side wall of the trench; and

burying a capacitor extraction electrode on the storage electrode and on the buried strap region in the trench.

11. The method as claimed in claim 9, wherein the first insulating film is a silicon nitride film, and the second insulating film is a silicon oxide film.

12. The method as claimed in claim 9, wherein the second insulating film is deposited by a CVD method.

13. The method as claimed in claim 9, wherein the semiconductor film is silicon germanium (SiGe).

14. The method as claimed in claim 13, wherein a mole fraction of germanium (Ge) in the silicon germanium film is equal to or greater than 50%.

15. The method as claimed in claim 13, wherein an etchant used in etching the semiconductor film includes hydrogen peroxide(H_2O_2).

16. The method as claimed in claim 9, further comprising:

etching the exposed side wall of the trench after etching the first insulating film and before forming the plate electrode.

17. The method as claimed in claim 9, further comprising:

forming irregularities on the exposed side wall of the trench after etching the first insulating film and before forming the plate electrode.